CLAIMS
(Clean Copy)

CLAIMS:

1. **(Amended)** A double shoulder connection joint (4) for use in a drill stem, having

a pin (10) with external threads (18) formed between a pin external shoulder (30) and a pin face (26),

a box (12) with internal threads (20) formed between a box external shoulder (28) and a box internal shoulder (24),

the box (12) having a counterbore section (14) between the internal threads (20) and the box external shoulder (28),

the pin having a base section (16) between the external shoulder (30) and the external threads (18), and a nose section (22) between the external pin face (26) and the external threads (18),

said internal threads (20) and said external threads (18) are arranged and designed for connection with each other so that said box (12) and said pin (10) are connected with a common center-line (*C/L*) and with a primary seal (*PS*) formed by said pin external shoulder (30) forced against said box external shoulder (28) and a secondary shoulder (*SS*) formed by said pin face (26) forced against said box internal shoulder (24), and

wherein said connection joint is characterized by,

said internal threads (20) and said external threads (18) having a thread taper (T_{th}) (C/L) which is greater than a thread taper ($T_{th\ lower}$) of 1.0 inch per foot, and which is less than an upper limit ($T_{th\ upper}$) of 1.2 inch per foot.

2. **(Original)** The connection of claim 1, wherein

thread form characteristics of pitch, thread major diameter, and thread pitch diameter are arranged and designed so that less than 8 turns are required from stabbed to snugged.

3. **(Original)** The connection of claim 2, wherein

said turns required from stabbed to snugged is about 6 turns with a thread taper of about 1.125 inch per foot.

4. **(Amended)** The connection of claim 1, wherein

said external and internal threads are characterized by a thread depth (h), measured between a major radius $\left(\frac{D_{MJ}}{2}\right)$ and a minor radius $\left(\frac{d_{MI}}{2}\right)$, is about one-half of the height (H) of a fundamental triangle of the threads.

5. **(Original)** The connection of claim 1, wherein

said internal threads (20) and said external threads (18) are characterized by a stab flank angle (Θ_S) between about 35 and about 42 degrees and a load flank angle (Θ_P) between about 25 and about 34 degrees.

6. **(Original)** The connection of claim 5, wherein

said stab flank angle (Θ_S) is about 40 degrees and said load flank angle (Θ_P) is about 30 degrees.

7. **(Original)** The connection of claim 1, wherein

roots of said internal threads (20) and said external threads (18) are formed in a shape of a portion of an ellipse (E).

8. **(Amended)** The connection of claim 1, wherein

said internal threads (20) and said external threads (18) are characterized by crests having a crest taper (T_C) which slopes at an opposite direction from that of said thread taper (T_{th}).

9. **(Original)** The connection of claim 5, wherein

said internal threads (20) and said external threads (18) are characterized by crests, and

a transition shape (44) between said load flank (36) and said crest (42) includes a radius of curvature equal to or less than 0.012 inch,

thereby providing a large load flank.

10. **(Original)** The connection joint of claim 5, wherein

said internal threads (20) and said external threads (18) are characterized by thread crest widths formed by the truncation of the threads of a total height (H), and

a transition shape (46) between said stab flank (34) of said crest (42) includes a radius of curvature greater than 80% of the said thread crest width, thereby enabling a gradual entry of the mating thread during stab-in and make up.

11. **(Original)** The connection of claim 7, wherein

roots of said internal threads (20) and said external threads (18) are characterized by an elliptical shape that produces a stress concentration factor less than that of a 0.038" root radius.

12. **(Original)** The connection of claim 1, wherein

said internal threads (20) and said external threads (18) are characterized by a thread form with a pitch of about 0.25 inches or greater.

13. **(Original)** The connection of claim 1, wherein

said nose section (22) of said pin (10) has a length (L_{PN}) equal to or greater than a length (L_{BC}) of said counterbore section (14).

14. **(Original)** The connection of claim 13, wherein

said length (L_{PN}) of said pin nose section (22) is about 1.25 inches and said length (L_{BC}) of said counterbore section (14) is about 1 inch.

15. **(Original)** The connection of claim 1, having

a pin nose cross section area, a counterbore cross-section area and a length L_{TH} of said internal threads (20) connected with said external threads (18) that are designed and arranged such that torque applied to the assembled connection causes substantial yielding to first occur in the weaker of the pin base section or the box counterbore section or of the pin nose.

16. **(Original)** The connection of claim 1, wherein

when said pin (10) and said box (12) are connected together, said box external shoulder (28) and said pin external shoulder (30) define a Primary Shoulder (*PS*) and said pin face (26) and said box internal shoulder (24) define a Secondary Shoulder (*SS*), and

said pin nose length (L_{PN}), said counterbore length (L_{BC}), a length (L_{TH}) of said internal threads (20) connected with said external threads (18), pin nose cross-sectional area (CS_{PN}), box counterbore area (CS_{BC}), pin base section area and tool joint outer and inner diameters (TJ_{OD}, TJ_{ID2}) are selected whereby secondary shoulder (*SS*) stress and primary shoulder (*PS*) stress at surface make-up are within 70% of each other depending on manufacturing tolerances of said lengths, areas and diameters.

17. **(Original)** The connection of claim 2, wherein

said thread taper (T_{TH}) is about 1.125 inch per foot

said external and internal threads are characterized by a thread depth (h), measured between a major radius $\left(\frac{D_{MJ}}{2}\right)$ and a minor radius $\left(\frac{d_{MI}}{2}\right)$, that is about one-half of the height (H) of a fundamental triangle of the threads,

said internal threads (20) and said external threads (18) are characterized by a stab flank angle (Θ_S) between about 35 and about 42 degrees and a load flank angle (Θ_P) between about 25 and about 34 degrees.

18. **(Amended)** The connection of claim 2, wherein

said thread taper (T_{th}) is about 1.125 inch per foot.

said stab flank angle (Θ_S) is about 40 degrees and said load flank angle (Θ_P) is about 30 degrees,

roots of said internal threads (20) and said external threads (18) are formed in a shape of a portion of an ellipse (E),

said internal threads (20) and said external threads (18) have a threaded taper (T_{th}), and

said internal threads (20) and said external threads (18) are characterized by crests having a crest taper (T_C) which slopes in an opposite direction than that of said thread taper (T_{TH}).

19. **(Original)** The connection of claim 18, wherein

said internal threads (20) and said external threads (18) are characterized by a thread form with a pitch of about 0.25 inch or greater,

said length (L_{PN}) of said pin nose section (22) is about 1.25 inches and said length (L_{BC}) of said counterbore section (14) is about 1 inch, and

said pin nose cross section area, said counterbore cross-section area and a length L_{TH} of said internal threads (20) connected with said external threads (18) are designed and arranged such that strength of the connected threads with torque applied is greater than the strength of said pin nose (22) or said box counterbore (14) or said pin base.

20. **(Original)** The connection of claim 19, wherein

when said pin (10) and said box (12) are connected together, said box external shoulder (28) and said pin external shoulder (30) define a Primary Shoulder (PS) and said pin face (26) and said box internal shoulder (24) define a Secondary Shoulder (SS), and

said pin nose length (L_{PN}), said counterbore length (L_{BC}), a length (L_{TH}) of said internal threads (20) connected with said external threads (18), pin nose cross-sectional area (CS_{PN}), box counterbore area (CS_{BC}) and tool joint outer and inner diameters (TJ_{OD}, TJ_{ID2}) are

selected whereby secondary shoulder (*SS*) longitudinal stress and primary shoulder (*PS*) longitudinal stress at surface make-up torque are within 70% of each other, depending on manufacturing tolerances of said lengths, areas and diameters.

21. **(Amended)** A double shoulder connection (4) for use in a drill stem, having

a pin (10) with external threads (18) formed between a pin external shoulder (30) and a pin face (26),

a box (12) with internal threads (20) formed between a box face (28) and a box internal shoulder (24),

the box (12) having a counterbore section (14) between the internal threads (20) and the box external shoulder (28),

the pin having a base section (16) between the external shoulder (30) and the external threads (18), and a nose section (22) between the external pin face (26) and the external threads (18),

said internal threads (20) and said external threads (18) are arranged and designed for connection with each other so that said box (12) and said pin (10) are connected with a primary seal (*PS*) formed by said pin external shoulder (30) forced against said box face (28) and a secondary shoulder (*SS*) formed by said pin face (26) forced against said box internal shoulder (24), and

wherein said connection is characterized by

said internal threads (20) and said external threads (18) have a stab flank angle (Θ_S) between about 35 and about 42 degrees and a load flank angle (Θ_P) between about 25 and about 34 degrees.

22. **(Original)** The connection of claim 21, wherein

said external and internal threads having a thread depth (h), measured between a major radius $\left(\frac{D_{MJ}}{2}\right)$ and a minor radius $\left(\frac{d_{MI}}{2}\right)$, that is about one-half of the height (H) of a fundamental triangle of the threads.

23. **(Original)** The connection of claim 21, wherein

said stab flank (Θ_S) angle is about 40 degrees and said load flank angle (Θ_P) is about 30 degrees.

24. **(Original)** The connection of claim 21, wherein

roots of said internal threads (20) and said external threads (18) are formed in a shape of a portion of an ellipse (E).

25. **(Amended)** The connection of claim 21, wherein

said internal threads (20) and said external threads (18) are characterized by crests having a crest taper (T_C) which slopes in an opposite direction than that of said thread taper (T_{th}).

26. **(Original)** The connection of claim 21, wherein

said internal threads (20) and said external threads (18) are characterized by crests, and

a transition shape (44) between said load flank (36) and said crest (42) includes a radius of curvature equal to or less than 0.012 inch,

thereby providing a large load flank.

27. **(Original)** The connection of claim 21, wherein

said internal threads (20) and said external threads (18) are characterized by thread crest widths formed by the truncation of the threads of a total height (H), and

a transition shape (46) between said stab flank (34) of said crest (42) includes a radius of curvature greater than 80% of the said thread crest width, thereby enabling a gradual entry of the mating thread during stab-in and make up.

28. **(Original)** The connection of claim 21, wherein

roots of said internal threads (20) and said external threads (18) are characterized by an elliptical shape that produces a stress concentration less than that of a 0.038 inch root.

29. **(Amended)** The connection of claim 22, wherein

said internal threads (20) and said external threads (18) have a taper (T_{th}) of about 1.125 inch per foot.

30. **(Amended)** A double shoulder connection (4) for use in a drill stem, having

a pin (10) with external threads (18) formed between a pin external shoulder (30) and a pin face (26),

a box (12) with internal threads (20) formed between a box external shoulder (28) and a box internal shoulder (24),

the box (12) having a counterbore section (14) between the internal threads (20) and the box external shoulder (28),

the pin having a base section (16) between the external shoulder (30) and the external threads (18), and a nose section (22) between the external pin face (26) and the external threads (18),

said internal threads (20) and said external threads (18) are arranged and designed for connection with each other so that said box (12) and said pin (10) are connected with a primary seal (*PS*) formed by said pin external shoulder (30) forced against said box external

shoulder (28) and a secondary shoulder (*SS*) formed by said pin face (26) forced against said box internal shoulder (24), and

wherein said connection is characterized by

said internal threads (20) and said external threads having crests (42), and

said internal threads (20) and said external threads have a crest taper (T_C) which slopes in a different direction from the center line of the drill pipe joint than a direction of slope from the centerline of said thread taper (T_{th}).

31. **(Original)** The connection of claim 30, wherein

said internal threads (20) and said external threads are characterized by a stab flank angle of (Θ_S) between about 35 and 42 degrees and a load flank angle (Θ_P) between about 25 and 33 degrees.

32. **(Original)** The connection of claim 31, wherein

said stab flank angle (Θ_S) is about 40 degrees and said load flank angle (Θ_P) is about 30 degrees.

33. **(Original)** The connection of claim 32, wherein

said internal threads (20) and said external threads (18) are characterized by thread crest widths formed by the truncation of the threads of a total height (H), and

a transition shape (46) between said stab flank (34) of said crest (42) includes a radius of curvature greater than 80% of the said thread crest width, thereby enabling a gradual entry of the mating thread during stab-in and make up.

34. **(Original)** A drill string comprising,

a first drill pipe (2) with a threaded box tool joint (12) welded (6) to an upset portion (3) thereof and a second drill pipe (2') with a threaded pin tool joint (10) welded to an upset portion (3') thereof, with said threaded pin tool joint (10) screwed into connection with said box tool joint (12) wherein

said first and second (2, 2′) drill pipes are characterized by a pipe outer diameter (P_{OD}) and a pipe inner diameter (P_{ID}), and by a pipe upset inner diameter (PU_{ID}),

said pin tool joint (10) and said box tool joint (12) are characterized by a tool joint outer diameter (TJ_{OD}), by a first tool joint inner diameter (TJ_{ID1}) at each weld end thereof and by a tool joint inner diameter (TJ_{ID2}) in a region adjacent box threads and pin threads wherein

said tool joint outer diameter TJ_{OD} is larger than said pipe outer diameter P_{OD},

said pipe upset inner diameter (PU_{ID}) in smaller than said pipe inner diameter (P_{ID}),

said pipe upset inner diameter (PU_{ID}) is larger than said tool joint inner diameter (TJ_{ID2}), and

said first tool joint inner diameter (TJ_{ID1}) is substantially equal to said pipe upset inner diameter (PU_{ID}) and said tool joint inner diameter (TJ_{ID2}) is smaller than said first tool joint inner diameter (TJ_{ID1}), wherein a wall thickness of said tool joint adjacent said pin and threads is enhanced for providing increased torque strength of the connection, and

a length of tool joint characterized by TJ_{ID2} is not greater than about 2/3 of the total tool joint length (L_{TJ}).

35. **(Amended)** A double shoulder connection (4) for use in a drill stem, having

a pin (10) with external threads (18) formed between a pin external shoulder (30) and a pin face (26),

a box (12) with internal threads (20) formed between a box external shoulder (28) and a box internal shoulder (24),

the box (12) having a counterbore section (14) between the internal threads (20) and the box external shoulder (28),

the pin having a base section (16) between the external shoulder (30) and the external threads (18), and a nose section (22) between the external pin face (26) and the external threads (18),

said internal threads (20) and said external threads (18) are arranged and designed for connection with each other so that said box (12) and said pin (10) are connected with a primary seal (*PS*) formed by said pin external shoulder (30) forced against said box external shoulder (28) and a secondary shoulder (*SS*) formed by said pin face (26) forced against said box internal shoulder (24), and

wherein said drill pipe joint is characterized by

a pin nose cross section area, CS_{PN} which is at least 50% as large as the smaller of the area of the cross section of box counterbore CS_{BC} or the cross-section of the pin base CS_{PB}, and

the pin nose length L_{PN} is from about 1 to 1.5 times the counterbore length L_{BC}.

36. **(Amended)** The connection (4) of claim 35 wherein

said counterbore section is characterized by a length L_{BC} of about 1".

37. **(Original)** The connection (4) of claim 36 wherein

thread characteristics of pitch, thread major diameter, and pitch diameter are arranged and designed so that less than 8 turns are required from stabbed to snugged.